PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION

Improvement in and relating to Helicopters

I, PIETER JACOBUS VAN POELVOORDE, of Hotel " De Zon ", Warmond (Z.H.), The Netherlands, a Subject of the Queen of The Netherlands, do hereby declare the nature of this invention to be as follows:—

This invention relates in general to aircraft of the helicopter type and more particularly to such aircraft being equipped with means of propulsion, in both horizontal and vertical directions, which may be co-ordinated in their operation to attain, on the one hand high speed in flight horizontally, and on the other hand to enable the aircraft to hover over a given restricted area in a substantial " standstill " position in a selected plane of elevation.

Another object of my invention is the provision of a means of universal connection between the power source for a rotary propellor (which supplies the lifting power) and the fuselage, to be provided beneath the power source, whereby angular adjustment of such power source may be effected relatively to the longitudinal axis of the fuselage to enable the latter to be maintained on an even keel in flight.

Still another object of the invention is the provision in a helicopter of a dual set of propellors mounted in tandem and driven in reverse directions by a common source of power whereby instability due to torque is eliminated in the lifting component of force of the helicopter.

As a further object of my invention I provide a plurality of such aforesaid power sources with the propellor(s) belonging to them in conjunction with a fuselage to be provided beneath the power sources.

Yet another object of my present invention is to provide a wing or wings to the above-said fuselage, co-operating with the source of power which drives the aircraft and support it, so arranged that they may be conveniently adjusted to and in the take-off and in horizontal flight of the aircraft in the first instance and in manoeuvring it from a standstill position in the air and in landing. To realize the above-said co-ordination of the horizontal and vertical means of propulsion, a worm-pinion and cog-wheel set together with a frictional connection in the cog-wheel are provided.

The engines driving the airscrews may also be used in conjunction with gas-jets.

Dated the twentyfourth day of April, 1946.

P. J. VAN POELVOORDE.

COMPLETE SPECIFICATION

Improvement in and relating to Helicopters

I, PIETER JACOBUS VAN POELVOORDE, of Hotel " De Zon ", Warmond (Z.H.), The Netherlands, a Subject of the Queen of The Netherlands, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates in general to aircraft of the helicopter type and more particularly to such aircraft being equipped with means of propulsion, in both horizontal and vertical directions, which may be co-ordinated in their operation to attain, on the one hand high speed in flight, and on the other hand to enable the aircraft to hover over a given restricted area in a substantial " standstill " position in a selected plane of elevation.

Another object of my invention is the provision of a means of connection between the power source for a rotary propellor (which supplies the lifting power) and the fuselage, to be provided beneath the power source, whereby angular adjustment of such power source may be effected relatively to the longitudinal axis of the fuselage to enable the latter to be main-

tained on an even keel in flight.

Still another object of the invention is the provision in a helicopter of a dual set of propellors mounted in tandem and driven in reverse directions by a common source of power whereby instability due to torque is eliminated in the lifting component of force of the helicopter.

As a further object of my invention I provide a fuselage with a plurality of the power sources and propellors.

Yet another object of my present invention is to provide a wing or wings to the above-said fuselage, co-operating with the source of power which drives the aircraft and supports it, so arranged that they may be conveniently adjusted for the take-off and for manoeuvring the aircraft from a standstill position in the air, and for landing. To realize the above-said co-ordination of the horizontal and vertical means of propulsion, a worm-pinion and cog-wheel set together with a frictional connection in the cog-wheel are provided.

To these and further ends my invention comprises further improvements and advantages as will be further described in the accompanying specification, the novel features thereof being set forth in the appended claims.

In the accompanying drawings:—

Figure 1 is a fragmentary schematic illustration showing in side elevation universally operating cross-hinge joints by which the fuselage of an helicopter is connected to the helicopters lifting power source, embodying a main part of my invention;

Figure 2 is a diagrammatic view illustrating certain components of force resulting from the location of two of the lifting elements located longitudinally or transversely of a fuselage in positions fore and aft of or on either side of the centre of gravity of the fuselage;

Figure 3 is a detail elevational view showing one form of mechanism for adjusting an engine to position the propellor into different planes of rotation;

Figures 4 and 4A are, respectively, a side elevation and plan view showing a small helicopter according to the present invention;

Figure 4B is a side elevation of a modified form of the helicopter;

Figure 5 shows side and top plan views respectively of a helicopter having the fuselage provided with two of the lifting components disposed at opposite sides of the centre of gravity;

Figure 6 shows side and top plan views respectively of a large passenger and/or cargo carrying form of helicopter in which a plurality of the lifting elements are mounted on opposite sides of the fuselage in sets located fore and aft of the centre of gravity of the helicopter.

Similar reference numerals in the several figures indicate similar parts and, for clearness of illustration, the cross-hinge joints, shown in Figure 1, have been omitted from the other figures.

The main and general object of my invention is to provide a helicopter construction which shall have the capability of attaining great speed in forward flight and be capable of effective stability when hovering at an elevation. Moreover, the arrangement of parts which I have provided is such that they are adapted for use with aircraft ranging from the smallest to the largest, the principle of operation in each case being the same.

An understanding of the principle of my invention may be gained by first considering the present known so-called rotating-wing helicopters which are of slow speed due to the flexibility of the long wings (which are movably connected to their driving axle) and the inability to adjust and secure them in such a position that during rotation they contribute noticeably to the forward driving or horizontal propelling force of the helicopter. Moreover these known rotating-wing helicopters are not in automatically stable balance when hovering (their balance having to be controlled) and that makes them extremely dangerous in inexpert hands. In contradistinction to this structure I provide at least one pair of co-axial counter-rotating rigid-bladed airscrews of which the lifting component can be adjusted and which can be held in such positions as are suited to the condition of flight of the aircraft (i.e., whether moving through space or hovering) that the body of the aircraft is so supported that it automatically assumes a level position when hovering, the propellor-axle maintaining a perpendicular position as hereinafter explained:—

In the drawings Figure 1 shows in simplified form a lifting system for a helicopter comprising a nacelle 1 containing an engine which rotates a driving shaft provided with an airscrew of any approved design. These parts are mounted above the aircraft, a portion of the fuselage thereof being indicated by 2. The connection between the latter and said nacelle is by means of a universal joint comprising cross-hinges, one element 6 thereof having an axis extending transversely of the fuselage and the other element 7 being movable on a longitudinally extending axis, the universal joint being such that the mutual relationship between said lifting or supporting system and the fuselage is such that both are balanced by gravity,

so that canting or tilting of the former is counteracted by the weight of the latter, the result being that said weight keeps the axis of the supporting structure upright in the hovering position of the aircraft. To accomplish this aim the lifting element is so disposed that the vertical axis of symmetry of both parts passes through the centre of gravity of the aircraft when in its normal stable position.

Thus when the lifting structure is canted relatively to the fuselage (and assuming that the cross-hinges 6—7 form a universal joint which is at a theoretical single central point) the weight-resultant P of the fuselage exerts upon the lifting structure 1 a balance-restoring couple $P \times q$, wherein " q " represents the horizontal distance between the centre of gravity Z^1 of the lifting or supporting structure and the vertical direction of the weight-resultant P. It is obvious that the couple $P \times q$ counteracts the canting of the lifting element structure. When the lifting structure is upright (i.e. when the propellor axis Z^1—6 is vertical and, consequently, " 6 " lies vertically below Z^1), the distance " q " becomes nought, so that the balance-restoring couple also becomes nought. In this case the supporting structure is in equilibrium, and the fuselage is then suspended from the lifting element with the whole system in a state of equilibrium both transversely as well as longitudinally of the aircraft. Toward the accomplishment of the above I annul the gyroscopic precession of a single propellor by adopting a similarly supported set of two coaxial counter rotating propellors, as indicated by 1 in the other Figures of the drawings. These two airscrews by rotating in opposite directions neutralize the torque effects of each other so that the balancing effect according to the present invention is very powerful and creates a stable condition under hovering conditions of the aircraft.

In Figures 4 and 4A I have shown one form of aircraft equipped with a single driving element comprising a motor-nacelle 1 jointed, as before described, to the fuselage 2 and serving both to lift the aircraft and to propel it in a forward direction. This dual effect is accomplished by adjusting the driving element on its transverse horizontal axis 6 to incline the propellor shaft forwardly at the desired angle in which position is is locked by suitable means 11, such as shown in Figure 3 and will be later described. In this Figure I have illustrated a structure having forward and rear horizontal wings carried on a frame. The adjustable locking member for the nacelle 1 is an arm 4^1 the free end of which is locked to the frame by entering in a slot 15, formed by the guides 16, to secure the propellor blades 1 in the necessary angular plane of rotation to afford both the propelling and lifting forces.

For convenience of description the combination of the supporting airscrew and engine with the movable connecting member is hereinafter called a " supporting unit ".

My invention further comprehends a tandem arrangement of the supporting units in which the units are located equal distances in front of and behind the centre of gravity of the fuselage or on either side of that centre as illustrated diagrammatically in Figure 2. Here the helicopter is furnished with two supporting units 1^a and 1^b which, when the aircraft is in a hovering position with the propellors rotating in a horizontal plane, act independently to exert forces along the lines 3^a—3^b. Hence if the fuselage 2 for any reason is forced out of a horizontal position momentarily, its equilibrium will automatically be restored. Considering Figure 2, in which the fuselage is shown tilted, it will be seen that force 1^a exerts a restoring moment $1^a \times a$ upon the fuselage (i.e. tending to move the latter towards a horizontal position), while 1^b exerts upon that fuselage a tilting moment $1^b \times b$ (i.e. a moment tending to tilt it further), " a " and " b " respectively representing the horizontal distances between the working-points 3^a and 3^b and the centre of gravity Z^2 of the fuselage 2. As the forces 1^a and 1^b, as has been assumed above, are equal, and as the distance " a " is obviously greater than the distance " b ", the restoring moment $1^a \times a$ will be greater than the tilting moment $1^b \times b$. It should however be kept in mind that " a " will only be greater than " b " if, in the normal horizontal position of the aircraft, Z^2 lies below the working-points 3^a and 3^b, it being understood, of course, that it is desirable in loading the aircraft that the cargo be distributed with reference to the centre of gravity. However, if this should be disregarded, although in a slant position, the aircraft will continue to hover if only the supporting or lifting units are upright, i.e. with their propellors rotating in an horizontal plane. In a helicopter, equipped with dual supporting units and flying horizontally changes in elevation and its direction of flight are accomplished by elevators and rudders, such as the usual controls as will be presently described.

A further object of my invention is the provision of a fixed-wing, similar to the orthodox aeroplane-wing, but smaller, to be fitted to the fuselage of the helicopter

for the following reasons:—

First: an auxiliary wing may contribute to the safe powerless landing of the helicopter in emergency;

Second: as the auxiliary wing is able to give additional support in flight, it will be possible to increase the inclination of the axle of the lifting airscrew and thus increase the speed of the helicopter when flying horizontally;

Third: with flaps provided thereon the auxiliary wing enables the helicopter to be directed upwardly and downwardly without an increase or decrease of the engine-power of the lifting mechanism.

The provision of a fixed-wing to a helicopter should be such that the wing does not hinder the airflow caused by the lifting mechanism.

As one means for accomplishing the above I have shown in Figures 4, 4A and 4B the location of the wings in front of and behind the lifting mechanism so that when the aircraft is hovering they do not interfere with the slip-stream of the propellors then rotating in a horizontal plane.

Another adaptation for effecting the fundamental idea of a wing type helicopter is shown in Figure 5. In this type of aircraft forward speed in level flight is accomplished partly by means of jet propulsion as illustrated.

A means for effecting the adjustment of the angular position of the supporting unit is illustrated in Figure 3. Here the transverse hinge 6 is attached fixedly to the nacelle 1, each end of it being supported by and turning in a bearing carried by a check-block 10 (see Figure 4) on either side of the apparatus, which are hingedly connected to the fuselage on a longitudinal hinge 7 in Figure 4. On said transverse hinge 6 in Figure 3 is a gear-wheel 12 connected thereto by a frictional connection 13, similar to a free-wheeling back-pedalling bicycle-brake, capable of being set to lock the gear wheel on the axle. Co-operating with gear 12 is a worm 11 operated by a shaft from within the fuselage. When the friction-brake is set, rotation of the worm will adjust the nacelle at any desired angle and by releasing the brake 13, the supporting unit will automatically turn to position its propellors in a horizontal position so that the action of the supporting unit is in a direction to enable the aircraft to hover in stable equilibrium, the forward propelling force being then gradually reduced to zero.

The principles of construction and operation heretofore described are shown in Figure 6 " elevation " and " plan " as applied to a large passenger aircraft or cargo carrying aircraft comprising a fuselage. Supplementary forward level flight propulsion of this aircraft is provided by turbine-driven airscrews, located at opposite sides of the fuselage. Symmetrically disposed with reference to the centre of gravity are a series of the supporting units arranged in pairs. With this multiple arrangement of supporting units the aircraft needs but a single pair of aerofoil wings, placed at right angles to the fuselage with their axis in line with the centre of gravity Z^2 of the fuselage. This wing is, for the purpose of controlling the directional flight of the plane, provided with ailerons. In this Figure (6) in the " elevation " the airscrews are shown in their flying position, while in the " plan " the airscrews are indicated by circles in the hovering position of the aircraft.

In addition to the above already mentioned favourable features of the stable helicopter the following may give a further view of its efficacy. It is known that the aeroplane's wing is much too large for its purpose in flight, due to the circumstance that the aeroplane needs that relatively-too-large wing to enable it to take-off from the ground. As on the other hand the wing-helicopter is able to rise and drop perpendicularly it has no need of the wing for take-off purposes. With regard to the possibility of enlargement of its size the wing-helicopter has once again a very good start of the aeroplane, due to the fact that in the former the pairs of supporting units are placed behind one another, each pair of units supporting a portion of the whole aircraft, whereas it is known to aircraft-designers that, in increasing the size of the aeroplane, the considerable structural weight of the fuselage and the wing, and of the necessarily strong attachments for them will result in such an increase in the total weight of the flying aeroplane that there will only be a slight load-carrying capacity available.

Considered from the above-mentioned points of view of being probably very efficacious and fast combined with its ability to rise and drop perpendicularly, whether or not combined with jet-propulsion, the stable fixed-wing helicopter will also make an excellent war-plane.

The provision of optionally vertically, or horizontally directed craft has often been considered, but only on the basis of an aeroplane and without regard to the inherent stable equilibrium of the aircraft, such as in British Specifications Nos. 534,864, 499,439, 441,445, 437,447 and 365,030. Through the lack of any means to afford stable equilibrium said craft is

not able to hover at standstill in the air, notwithstanding the claims of authors of such aircraft-suggestions that their craft would be stable. On the contrary my invention provides in all its forms a stable helicopter, the body of which may carry a wing or wings, stable balance being inherent to it as has been explained in the foregoing.

I am aware that it has hitherto been proposed to provide an aircraft with an autorotative sustaining rotor of which the axis can be tilted, by control means, with respect to the fuselage, but the rotor is disposed forwardly of the centre of gravity of the aircraft and is to coact with a tail plane for flight purposes. According to another proposal an aircraft is provided with a sustaining rotor of which the hub is to be supported in a co-planar gimbal arrangement and of which the blades are to be universally supported with respect to the hub, the latter to be driven through an articulated shaft from a motor within the fuselage. Moreover, in the latter too, the rotor is not specially disposed vertically above the centre of gravity of the fuselage, as has been provided for in the present invention, so that none of said prior structures has stable equilibrium when hovering.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. A helicopter comprising a supporting and propelling unit and a fuselage beneath this unit, the unit comprising an engine and a propellor, of which latter the blades are rigid with the hub (or a pair of similarly supported coaxial, counter-rotating propellors) to be driven thereby, and a support between the said unit and the fuselage, the said support comprising a journal of which the axis extends longitudinally of the fuselage and which serves for hingedly inter-connecting the said support and the top of the fuselage, and a second journal of which the axis extends transversely of the fuselage and which serves for hingedly inter-connecting the support and the said unit, there being means serving for positioning the unit for the axis of the propellor either to be perpendicular, or tilted forwardly, with respect to the longitudinal axis of the fuselage in a plane at right angles to the longitudinal vertical plane passing through the centre of gravity of the fuselage.

2. A helicopter, as set forth in Claim 1, having an aerofoil wing on the fuselage, extending laterally of the centre of gravity of the fuselage, and a coacting tail plane, or having two laterally extending wings on the fuselage located respectively forward and in rear of said centre of gravity so as to be spaced, longitudinally of the helicopter, from the said unit, and elevators and lateral controls on the fuselage.

3. A helicopter, as set forth in Claim 1, comprising a plurality of the said units disposed at intervals along the length of the fuselage

4. A helicopter, as set forth in Claim 3, having an aerofoil wing on the fuselage extending laterally of the centre of gravity of the fuselage and spaced between two said units, and elevators and lateral controls on the fuselage.

Dated this 27th day of April, 1946.

P. J. VAN POELVOORDE.

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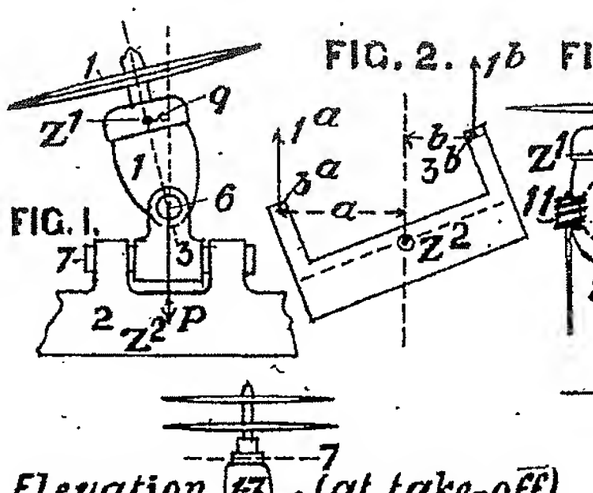

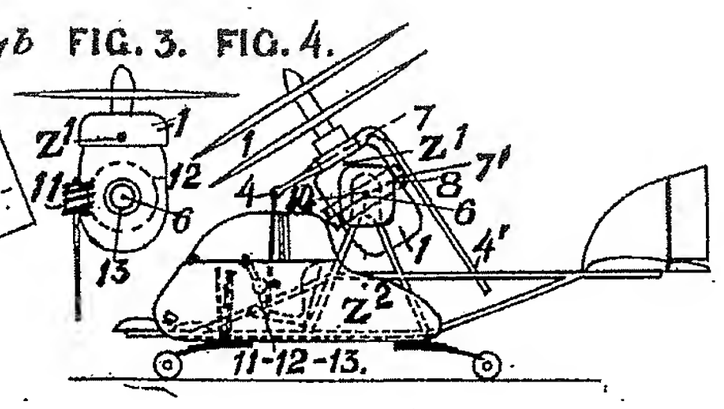

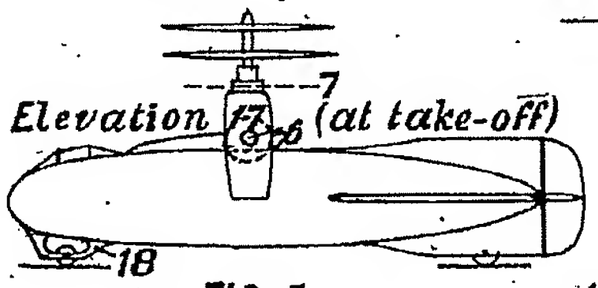

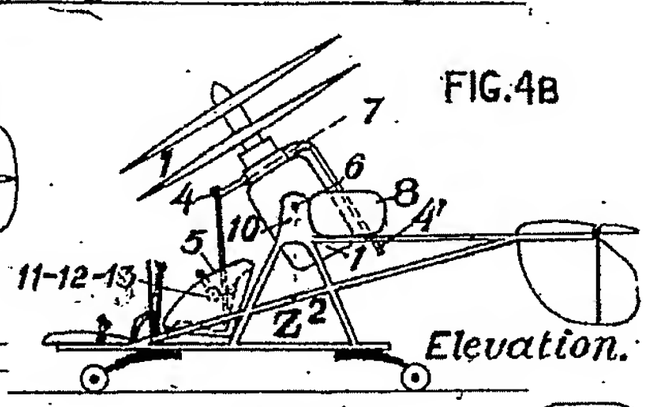

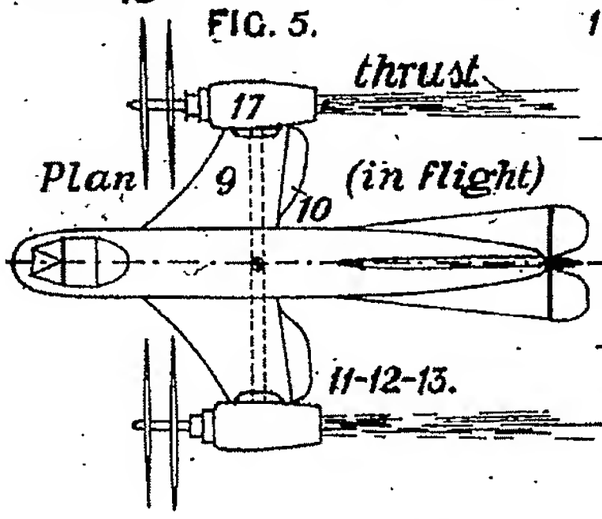

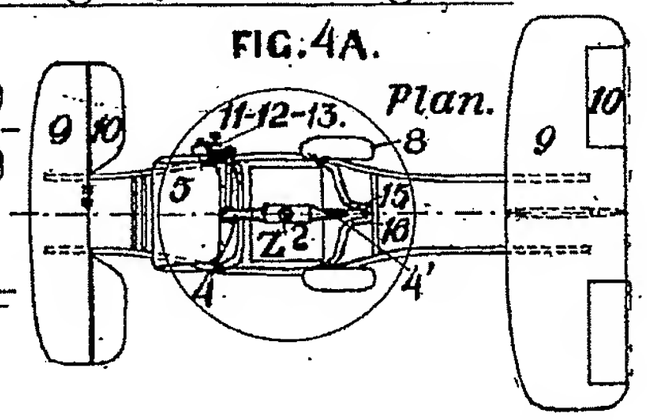

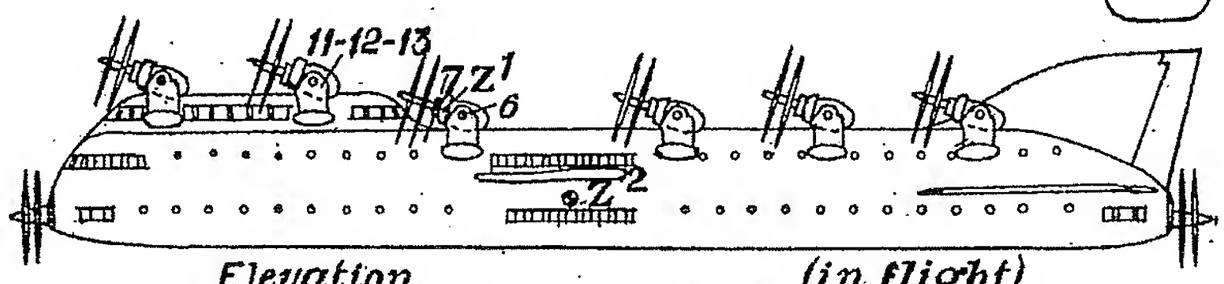

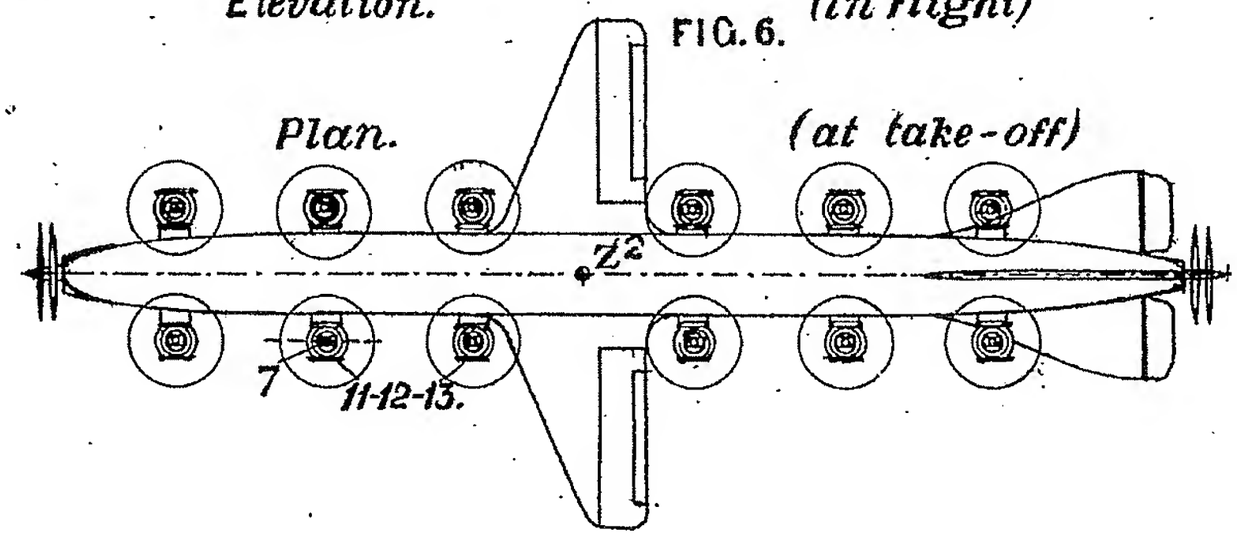

H.M.S.O.(Ty. P.)